PATENT
Attorney Docket No.: PD-970636A
Customer No.: 29158

RESPONSE UNDER 37 C.F.R. § 1.116
EXPEDITED PROCEDURE
EXAMINING GROUP NO. 2151

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Examiner: Nghi V. Tran
DOUGLAS M. DILLON, et al.	Group Art Unit: 2151
Appln. No.: 10/010,521	
Filed: December 7, 2001	
For: METHOD AND APPARATUS FOR SELECTIVELY ALLOCATING AND ENFORCING BANDWIDTH USAGE REQUIREMENTS ON NETWORK USERS	

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 C.F.R. § 1.131 OF
DOUGLAS M. DILLON AND VIVEK GUPTA

Sir:

We, Douglas M. Dillon and Vivek Gupta, hereby declare that:

1. We are the inventors of the inventions described and claimed in the above-identified patent application.

2. Prior to March 6, 1998, we conceived in the United States the inventions set forth in Claims 17, 18, 21 through 24, 26 through 28, 31 through 34,

36, 37, 47, 48, 51 through 54, 56, and 57 of the above-identified patent application, as set forth in the Claim Sheet attached as Exhibit 1.

3. Also prior to that date, we prepared a description entitled "DirecPC Turbo-Throttling Feature Requirements Specification".

4. A copy of the description from which dates have been redacted is attached as Exhibit 2.

5. The description evidences the conception of the inventions of the claims.

6. With respect to Claims 17, 21, 22, 26, 27, 31, 32, 36, 37, 47, 51, 52, 56, and 57, conception is evidenced, e.g., by the reference in the description that the hybrid gateway (HGW) maintains a running average throughput for a user and if the user's throughput exceeds a threshold, the user's TCP window size may be clamped, and by the references to "per user" throttling and the reference in the description to "service plan". (See, e.g., Exhibit 2, §§ 3.1.1 through 3.1.6, and "Turbo-Throttling II" Data Sheet.)

7. With respect to Claims 18, 28, and 48, conception of amount of data per unit time is evidenced, e.g., by the mention of measures such as kbps and MB/hr. (See, e.g., Exhibit 2, Parameters for Turbo-Throttling II Data Sheet.)

8. With respect to Claims 23, 33, and 53, conception of throttling in accordance with the "number of TCP connections" and the "level of service" is evidenced, e.g., by the references in the description to the number of TCP connections being limited to the MaxConnections configured for the corresponding service plan. (See, e.g., Exhibit 2, § 3.1.7.)

9. With respect to Claims 24, 34, and 54, conception is evidenced, e.g., by the description mentioned above in paragraph 6 of this declaration, together with the references to (a) "bucket leak" and (b) either window size clamping or discarding UDP packets. (See, e.g., paragraph 6, supra, as well as Exhibit 2, § 3.1.8.)

10. Thereafter, and prior to March 6, 1998, we constructed an actual device implementing the inventions of the foregoing claims.

11. The device operated successfully prior to that date.

12. This evidenced by an email that my coworker Rod Ragland sent out prior to March 6, 1998.

13. In that email, he indicated that he would analyze statistics from the "Turbo-Throttle II gateways".

14. A copy of that email from which dates and information relating to matters other than Turbo Throttling have been redacted is attached as Exhibit 3.

15. That the device operated successfully prior to March 6, 1998, is further evidenced by an email that my coworker Harvey Lindenbaum sent prior to that date.

16. In that email, he indicated that "FIT testing of Turbo Throttling 2 has been completed".

17. This means that all aspects of the project were successfully tested.

18. A copy of his email from which dates and information relating to matters other than Turbo Throttling has been redacted is attached as Exhibit 4.

19. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of this application and any patent issuing thereon.

02/28/2006
Date (Month/Day/Year)

Douglas M. Dillon

02/06/2006
Date (Month/Day/Year)

Vivek Gupta

PATENT
Attorney Docket No.: PD-970636A
Customer No.: 29158

I hereby certify that this correspondence is being deposited with the United States Postal Service as first-class mail in an envelope addressed to Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on Feb. 28, 2006.

Craig Plastrik

EXHIBIT 1

CLAIM SHEET

17. A gateway for use in a system wherein a first apparatus, said gateway, and a second apparatus are in a TCP/IP network, wherein the source apparatus, said gateway, and the second apparatus have different IP addresses, said gateway comprising:

a packet receiving unit that is configured to receive a packet addressed at the IP level from the first apparatus to the second apparatus; and

a service plan determining unit that is configured to determine a level of service subscribed to by a user of the first apparatus;

a throttling unit that is configured to throttle the user of the first apparatus by (a) adjusting the transport level window size of the packet in accordance with (1) the level of service subscribed to by the user of the first apparatus and (2) bandwidth usage associated with the user of the first apparatus, and (b) sending the so adjusted packet to the second apparatus,

wherein the packet received by said packet receiving unit has, as its source IP address, the IP address of the first apparatus, and has, as its destination IP address, the IP address of the second apparatus.

18. A gateway according to Claim 17, wherein the bandwidth usage is measured as an amount of data per unit of time.

21. A gateway according to Claim 17, wherein the bandwidth usage is expressed as an average throughput.

22. A gateway according to Claim 17, wherein the bandwidth usage is determined using a leaky bucket analysis.

23. A gateway for use in a system wherein a source first apparatus, said gateway, and a second apparatus are in a TCP/IP network, each of the first apparatus, said gateway, and the second apparatus having different IP addresses, said gateway comprising:

a throttling unit that is configured to (a) determine the number of TCP connections that are open and (b) throttle a user of the first apparatus in accordance with (1) the determination of the number of TCP connections that are open and (2) a level of service subscribed to by the user of the first apparatus.

24. A gateway for use in a system wherein a first apparatus, said gateway, and a second apparatus are in a TCP/IP network, each of the first apparatus, said gateway, and the second apparatus having different IP addresses, said gateway comprising:

a throttling unit that is configured to throttle a user of the first apparatus in accordance with (1) a leaky bucket analysis of the user's throughput and (2) a level of service subscribed to by the user,

wherein said throttling unit intercepts a packet on a TCP/IP connection between the first apparatus and the second apparatus; and

wherein one of the following two conditions is satisfied: (1) said throttling unit effects the throttling by discarding the packet and (2) said throttling unit effects throttling by modifying a field in the packet.

26. An apparatus according to Claim 17, wherein said throttling unit compares bandwidth usage to a threshold.

27. A method for use in a system wherein a first apparatus, a gateway, and a second apparatus are in a TCP/IP network, each of the first apparatus, the gateway, and the second apparatus having different IP addresses, said method comprising:

intercepting by the gateway of a packet addressed at the IP level from the first apparatus to the second apparatus; and

determining a level of service subscribed to by a user of the first apparatus;

determining whether or not to throttle a user of the first apparatus in accordance with (a) the level of service and (b) bandwidth usage by the user;

throttling by the gateway of the user of the first apparatus in accordance with a determination in said determining step that the user of the first apparatus should be throttled, said throttling comprising (1) adjusting, by the gateway, of the

transport level window size of the packet received in said receiving step and (2) sending the so adjusted packet to the second apparatus,

wherein the packet received in said receiving step has, as its source IP address, the IP address of the first apparatus, and has, as its destination IP address, the IP address of the second apparatus.

28. A method according to Claim 27, wherein the bandwidth usage is measured as an amount of data per unit of time.

31. A method according to Claim 27, wherein the bandwidth usage is expressed as an average throughput.

32. A method according to Claim 27, wherein the bandwidth usage is determined using a leaky bucket analysis.

33. A method comprising:

determining a number of TCP connections that are open; and

throttling, by a gateway for use in a system wherein a first apparatus, the gateway, and a second apparatus are in a TCP/IP network, of a user of the first apparatus, in accordance with (1) the determination of the number of TCP connections that are open and (2) a level of service subscribed to by the user.

34. A method comprising:

throttling by a gateway for use in a system wherein a first apparatus, the gateway, and a second apparatus are in a TCP/IP network, of a use of the first apparatus, in accordance with (1) a leaky bucket analysis of the user's throughput and (2) a level of service subscribed to by the user,

wherein the first apparatus, the gateway, and the second apparatus have different IP addresses, and

wherein the gateway intercepts a packet on a TCP/IP connection between the first apparatus and the second apparatus and wherein one of the following two conditions are satisfied: (1) said throttling comprises discarding of the packet and (2) said throttling comprises modifying a field in the packet.

36. A method according to Claim 34, wherein said throttling step comprises modifying the transport level window size field of the packet in response to bandwidth usage exceeding a threshold.

37. A gateway according to Claim 18, wherein the transport level window size is the TCP window size field of the packet.

47. A gateway for use in a system wherein a first apparatus, said gateway, and a second apparatus are in a TCP/IP network, each of the first apparatus, said gateway, and the second apparatus having different IP addresses, said gateway comprising:

packet receiving means for receiving a packet addressed at the IP level from the first apparatus to the second apparatus;

service plan determining means for determining a level of service subscribed to by a user of the first apparatus; and

throttling means for throttling a user of the first apparatus by adjusting the transport level window size of the packet received by said packet receiving means in accordance with (1) the level of service subscribed to by the user of the first apparatus and (2) bandwidth usage associated with the user of the first apparatus,

wherein the packet received by said packet receiving means of said gateway has, as its source IP address, the IP address of the first apparatus, and has, as its destination IP address, the IP address of the second apparatus.

48. A gateway according to Claim 47, wherein the bandwidth usage is measured as an amount of data per unit of time.

51. A gateway according to Claim 47, wherein the bandwidth usage is expressed as an average throughput.

52. A gateway according to Claim 47, wherein the bandwidth usage is determined using a leaky bucket analysis.

53. A gateway for use in a system wherein a first apparatus, said gateway, and a second apparatus are in a TCP/IP network, each of the first

apparatus, said gateway, and the second apparatus having a different IP address, said gateway comprising:

throttling means for determining a number of TCP connections that are open and for throttling a user of the first apparatus, in accordance with (1) the determination of the number of TCP connections that are open and (2) a level of service subscribed to by the user.

54. A gateway for use in a system wherein a first apparatus, said gateway, and a second apparatus are in a TCP/IP network, said gateway comprising:

throttling means for throttling a user of the first apparatus, in accordance with (1) a leaky bucket analysis of a user's throughput and (2) a level of service subscribed to by the user,

wherein said throttling means intercepts a packet on a TCP/IP connection between the first apparatus and the second apparatus, and

wherein one of the following conditions is satisfied: (1) said throttling means effects the throttling by discarding the packet and (2) said throttling means effects the throttling by modifying the packet.

56. An apparatus according to Claim 53, wherein said throttling means compares bandwidth usage to a threshold.

57. A gateway according to Claim 48, wherein said throttling means modifies the TCP window size field of the packet.

EXHIBIT 2

DirecPC™

HUGHES
NETWORK SYSTEMS
A HUGHES ELECTRONICS COMPANY

DirecPC
Turbo-Throttling
Feature Requirements Specification

Document HNS-11232

Version 1.1

[redacted]

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Revision History

Revision	Date of Issue	Author	Scope
0.1	[redacted]	Vivek Gupta	Initial draft
0.2	[redacted]	Vivek Gupta	Incorporated inspection comments
0.3	[redacted]	Vivek Gupta	Redo draft based on new (Hourly) Service Plan definition
0.4	[redacted]	Vivek Gupta	Added a requirement and incorporated changes suggested in Inspection
0.5	[redacted]	Vivek Gupta	Incorporated changed data sheet, incorporated Doug's comments (Highest ReqId: 0032)
0.6	[redacted]	Vivek Gupta	Incorporate new data sheet, drop terrestrial redirect and use window sizing for differentiated levels of service (Highest ReqId: 0035)
1.0	[redacted]	Vivek Gupta	Changes for Turbo-Throttling II (added data sheet, modified Reqs 0033, 0034; added Reqs 0036-0043)
1.1	[redacted]	Vivek Gupta	Added data sheet for configuring Turbo-Throttling II parameters

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Chapter 1
Introduction

1.1 Purpose

The purpose of this document is to define the requirements for the DirecPC Turbo-Throttling feature. This document has several goals:

- Establish a basis for agreement between Engineering and various operating divisions of HNS about what the product must do to meet the needs of the customer and those who must manufacture, support, and maintain it;
- Provide a basis for generating a project plan, estimating costs and schedules;
- Provide a basis for validation and verification of the final product;
- Provide a basis for maintenance and enhancement of the product.

1.1.1 Intended Audience

This document is applicable to all of the HNS operating divisions that will fund, implement, manufacture, sell, use, maintain, and support this capability such as:

- Hardware and Software Engineering
- Production, Quality Assurance, and System Test
- Field Services (Installation and Maintenance)
- Customer Services - Training, Support, Documentation
- Program Management
- Marketing
- Applications Programmers
- Legal

At the discretion of Program Management, some portions of this document may be disclosed to prospective customers.

1.2 Scope

This document defines the requirements for the Turbo-Throttling feature as it affects the DirecPC NOC and Remote software.

1.3 Terminology

It is expected that all requirements and capabilities listed in this document will be implemented for the current release and all future releases of this system. Each requirement in this document must be identified using one of the notations described in Table 1:

Table 1. Requirements Criteria

[R:nnnn]	Indicates meeting this requirement is **required**
[O:nnnn]	Indicates meeting this requirement is an **objective**. An objective is within the current scope of the features, but may be sacrificed to meet schedule
[D:nnnn]	Indicates meeting this requirement is **desirable**. A desirable requirement is one which would be nice to have, but has been prioritized as not being important enough to actually build. A desirable requirement is not within scope (will not be built).
[X:nnnn]	Indicates a requirement which was suggested at one time, but which has already been decided as not something we are at all interested in doing. X:nnnn requirements are sometimes left in a document to document that a requirement has been specifically rejected

Together, the letters **R**, **O**, and **D**, and the **nnnn** portion of the notation form a Document-Unique Requirement ID (DURID) that uniquely identifies the requirement. The **nnnn** portion of the DURID can be any numeric value as long as it, together with the letter **R**, **O**, or **D** form an ID that is unique across the whole document. The **document number + DURID** form a primary key used to identify a specific requirement in a requirements traceability matrix.

The following is a list of constraints related to the use of DURIDs:

- DURIDs must be enclosed in square brackets [] and only one DURID must be enclosed in a set of brackets. This is to ensure consistent markup and facilitate future automated requirement lookup schemes.
- DURIDs should be placed after paragraph numbers and at the beginning of each requirement listed.
- Once a DURID is assigned to a requirement, it must never change.
- DURIDs identify a single requirement for the life of that requirement.
- DURIDs should not be reused when a requirement is deleted if a requirements traceability matrix already exists for the feature described by this document.
- DURIDs can be duplicated if they are in different documents.
- The **nnnn** portion of the DURID should be unique across the document without regard to the DURID letter portion. This allows a document writer to more easily determine the next available DURID number because the combination of letter + number does not need to be taken into account. This would also enable development of an automated DURID numbering macro, for instance, to be simplified.

The following are examples of requirements identified using the DURID notation:

3.1.2. [R:0001] A Requirement To Do This Thing

3.1.2. [O:0002] This Thing Should Be An Objective

3.1.3. [D:0003] A Desire To Do This Other Thing

1.4 Definitions and Acronyms

This section provides definitions for all acronyms and terms introduced in or unique to this document.

Table 2. Definitions and Acronyms

Term	Description
Customer/User	The end user of the DirecPC software
NOC	DirecPC Network Operations Center
DirecPC Access Kit (DAK)	The hardware and software that comprises the remote DirecPC product
HGW	Hybrid Gateway

1.5 References

[1] DirecPC Turbo-Internet Statistics Feature Requirements Specification

[2] DirecPC Turbo-Internet Statistics Feature Design Specification

1.6 Open Issues

- There are no open issues

[redacted]

DirecPC™ Turbo-Throttling

Data Sheet

The DirecPC Turbo-Throttling feature provides the additional capabilities to DirecPC Turbo-Internet to support an enforced running average fair use policy and also performance-differentiated levels of service. The highlights of Turbo-Throttling include:

- Maintaining a running average of the user's total throughput. The running average calculation is based on the leaky-bucket approach used for rate-based flow control in ATM and Frame Relay. The running average is maintained across user sessions.
- Assigning an intial per-connection TCP window size WMax to each user and clamping it to W1 or W2 when the running average throughput exceeds thresholds T1 and T2 (T1 <= T2). WMax, W1 and W2 will each be greater than the minimum segment size (536 bytes) and WMax >= W1 >= W2.
- Optionally, providing two levels of (non-DNS) UDP discard, U1 and U2, linked with T1 and T2 respectively (1 <= U2 <= U1 <= 1000). If T1 is reached, every U1th (say, 50th) UDP packet will be dropped and if T2 is reached, every U2th (say, 1st that is, every) packet will be dropped.
- Optionally giving users a better initial experience, by having the HGW not include the first X minutes (default = 0) of activity each day in the running average. During this time the user may run at whatever rate he can achieve.
- Provide a means to enable/disable data forwarding when a user is not connected (F: enable disconnect forwarding) on a service plan basis.
- Modifying DAK and HGW software so that active minutes in billing records equal connected minutes.
- Updated auto-commissioning and Turbo-Internet statistics
- Modifying Auto-commissioning software to allow the configuration of T1, T2, D, WMax, W1, W2, U1, U2, F and X on a service plan basis. The HGW reconfiguration process will also be modified to include the service-plan information for each user.

The Per-Service Plan Turbo-Throttling parameters are as follows:

- D: Duration over which Running Average Throughput is calculated, default 60 minutes.
- WMax: Maximum window size for a TCP connection - used to limit the service plan's relative performance (single connection throughput), 48 kbytes is roughly equivalent to 400 kbps, 24 kbytes is roughly equivalent to 200 kbps.
- T1, T2: Throughput Thresholds - increasing throughput clamping is employed as the running average throughput exceeds these values. Defaults, T1 = 40kbps, T2 = 64 kbps.
- W1, W2: Clamped window sizes when running average throughput exceeds T1 and T2 respectively. For example E1 = 2000 bytes and W2 = 600 bytes.
- U1, U2: Defines the UDP discard rate when the running average throughput exceeds T1 and T2 respectively. For example, U1 = 50, that is, 1 out of 50 and U2 = 1, that is, 1 out of 1 (every packet).
- F, Enable Disconnect-Data forwarding
- X, Daily Initial Un-averaged Minutes - non-zero ensures a good initial experience for the user.

[redacted]

DirecPC™ Turbo-Throttling II

Data Sheet

DirecPC Turbo-Throttling II is intended to provide a stricter enforcement of the Turbo-Internet fair use policy and to prepare for ISP Bundling. The highlights of Turbo-Throttling II include:

- TCP connection limiting: Defines the number of simultaneous TCP connections that can be opened by a user.
- Per-user throughput throttling: **When throttled**, the user's bandwidth will be shared among the TCP connections. This will ensure that, even with multiple connections, a user's aggregate throughput will not exceed the configured value. The bandwidth will be shared by dividing the window size equally among all "bulk-transfer" type connections.

  (Note: A connection is classified as a "bulk-transfer" connection if, in the *recent past*, the number of unacknowledged bytes exceeded a configured value, typically 1kbytes. Otherwise, the connection is classified as an "interactive" connection. It may be noted that all connections start off as "interactive" connections and may become "bulk-transfer" later).
- Change in Flow Control (FC) Mechanism: Under high load conditions, the flow control mechanism throttles the window size of each TCP connection to the *same value*. This has led to a condition wherein a hard-throttled user's TCP window is not affected at all, while a non-throttled user's TCP window may shrink to a size equal to the hard-throttle window size. The new FC mechanism will maintain a FC meter (with values from 1% to 100%); the meter value will be computed based on the load conditions on SGW. A user's effective window size will be determined by multiplying this percentage with the window size derived on the basis of his throttled state.
- Bucket leak: New parameters will be added to specify the bucket leak when connected and when disconnected. The latter leak rate will be employed especially for users with ISP Bundling service plans, so that they do not stay connected at HNS' expense just to reduce their running average throughput.
- New Per Service-Plan parameters (added to TurboInetServices table):
  - Max TCP Connections, Connected Leak rate (kbps), Disconnected Leak rate (kbps)
  - Peak-UnThrottled Throughput (kbps), Peak-SoftThrottled Throughput (kbps), Peak-HardThrottle Throughput (kbps): These, in turn, will yield window sizes (with RTT being set on a per-HGW basis)
- Enhanced TIStats: The following fields will be added (on a per-user basis) to the TIStats table:
  - Number of TCP connections rejected, Number of Hard Throttled Minutes, MaxBulkTransferConns
  - Service Plan of the user, Hybrid Gateway Id, Bytes Received

The following HGW enhancements will also be bundled with Turbo-Throttling II:

- Local Key Table: The HGW maintains a table to store the encryption keys for each remote. This table will now store key information only for the remotes configured on the particular HGW.
- Unlimited number of service plans: The last release of HGW (HGNT1.8.4) limited the service plans to 30. The new release (HGNT2.x) will not restrict the number of service plans.

Backward compatibility:

- Oracle database upgrade with no HGW upgrade: HGW will ignore the new parameters
- HGW upgrade with no database upgrade: HGW assumes version 1 of Throttling with MaxTCPConns = 100 and DisconnLeakRate = 0 for all service plans

[redacted]

Parameters for DirecPC™ Turbo-Throttling II

Data Sheet

The following data sheet explains the Turbo-Throttling parameters and lays down thumb rules for assigning values to these parameters. Turbo-Throttling maintains a leaky-bucket for each user; the following parameters are associated with the bucket (and are configurable on a service plan basis):

- L_1 - Leak rate (kbps): A user downloading data at this average rate would have a zero bucket depth (B, in bytes). The data sent to the user over the satellite causes increase in bucket depth. Every minute, a finite number of bytes is subtracted from the bucket depth to account for leaking.
- L_2 - Disconnected Leak Rate (kbps): The rate at which the bucket leaks when a user is not connected. This has been introduced to discourage users from keeping their modem connections up in order to reduce their running-average; especially if they use Bundled-ISP service plans.
- D - Duration (min): The duration over which the running average throughput (RAT) is calculated (RAT = B/D). RAT is displayed in Gateway statistics and is included in TIStats
- T_1 - Soft-Throttle Threshold (kbps): The average data rate that a user can maintain over a period of D minutes without encountering any throttling. A user is soft-throttled when his bucket depth becomes greater than $(T_1 - L_1) * D$ bytes
- T_2 - Hard-Throttle Threshold (kbps): The average data rate that a user can maintain over a period of D minutes without encountering any hard-throttling. A user is soft-throttled when his bucket depth becomes greater than $(T_2 - L_1)* D$ bytes
- P_0 - UnThrottled Peak Throughput (kbps): The maximum throughput that a user can get when not throttled. (The un-throttled window size = P_0 * RTT, RTT = Estimated Round-Trip Time)
- P_1 - Soft-Throttle Peak Throughput (kbps): The maximum throughput that a user can get when in soft-throttled state. (The soft-throttle window size = P_1 * RTT)
- P_2 - Hard-Throttle Peak Throughput (kbps): The maximum throughput that a user can get when in hard-throttled state. (The hard-throttle window size = P_2 * RTT)

The following spreadsheet provides sample values for MoonSurfer II:

DirecPC Turbo Throttling II Parameters (with sample settings for MoonsurferII)							
L_1	28	kbps	12.6	Mbyte/hr	{=Leak Rate*3600/8*1000}		MB/hr with 0 bucket depth
T_1	120	kbps	31.05	MByte	{=(T_1 - L_1)*D*60/8*1000}		MB in D min w/ no throttling
T_2	200	kbps	58.05	MByte	{=(T_2 - L_1)*D*60/8*1000}		MB in D min w/ no hard-throttling
D	45	min					
P_0	200	kbps	15000	bytes	{=P_0*RTT*1000/8}		Un-Throttled Window Size
P_1	112	kbps	8400	bytes	{=P_1*RTT*1000/8}		Soft-Throttle Window Size
P_2	56	kbps	4200	bytes	{=P_2*RTT*1000/8}		Hard-Throttle Window Size
RT	0.6	seconds					
Active Users on 24 Mbps Xponder @ Leak Rate (N)						771.43	{=24000*0.9/L_1}
% Active Users During Busy Hour (X)						8	
Users Per Transponder (U)						9642.9	{=N/(X/100)}
Revenue @ $20 per user per month						192857	{=U*20}

The following thumb rules should be adhered to:

- T_1, L_1 and D should be chosen such that a user can download at least 25 Mbytes (size of the biggest browser download) without any throttling.
- L_1 should equal economically sustainable average bit rate (ABR) for a service plan, that is, L_1 should be such that the it satisfies the revenue requirements. In particular, the ABR for a service plan should be monitored and P_1 and P_2 should be adjusted until ABR equals L_1 (Note: To maintain a "happy" customer base, L_1 should be more than the ABR for enough users)
- P_0 equals the maximum data rate for the particular service plan; T_2 is typically <= P_0.
- P_1:P_2 ratio should be approximately 2:1

Chapter 2
Overview

2.1 Overview

The Turbo-Throttling feature is designed to allow a fair access to NOC resources to all users and to provide performance-differentiated levels of service. It also allows throughput reduction (via window sizes) if average throughput over a time period exceeds (service-plan configurable) thresholds.

The feature also changes the definition of active minutes used in Billing records to equal the actual "connected" minutes (instead of the previous definition of "the minutes in which some user-data traverses the NOC").

The Billing system will be required to provide a flat-file which contains the site-id and service plan information for each user, say, on a daily basis.

2.2 Deliverables

- Updated Hybrid Gateway (WinNT) executables
- Updated DAK software
- SCO UNIX shell scripts and executables for uploading service-plan information from the Billing system and updating the Oracle Database
- Enhanced Oracle Forms to allow changes in Turbo-Throttling parameters (on a service-plan basis)
- Enhanced Oracle triggers to reconfigure Hybrid Gateways with change of service plan of individual users and/or change in Turbo-Throttling parameters
- ACS Upgrade Procedure
- Feature Design Document
- Feature Integration Test Plan
- Updated NOC Manual
- Updated Oracle Schema Document
- Updated DirecPC Product Technical Specification (description of ascii-file used for updating Service Plan information)

2.3 Compatibility and Expected System Impact

This section identifies the expected impact of this feature on various subsystems and specifies the compatibility requirements for the feature in tabular form (Table 4). The table indicates:

- Which system components are expected to be modified.
- Whether new NOC hardware or third-party software is required by the NOC for this feature. This is important as DirecPC franchises may be required to purchase the hardware or software.
- Whether the modified component is backwards compatible with the NOC, DAK or APPs as they existed prior to this feature. Backwards compatibility with earlier DAK and APP software is a requirement. Backwards compatibility with the NOC is highly desirable, especially for DAK and APP software as it allows the DAK and APP software to be released prior to upgrading the NOC.

Table 4. Compatibility and Expected System Impact

Subsystem	Mod (Y/N)	New NOC HW/ 3rd party SW	Backwards Compatibility			Other Compatibility Concerns
			NOC	DAK	APP	
NOC	Y	N	Y	Y	Y	HGW upgrade should be done prior to the rest of the NOC
MUX	Y	Y	Y	Y	Y	
CAC	N	N	Y	Y	Y	
Pkg Del	N	N	Y	Y	Y	
MM BCast	N	N	Y	Y	Y	
Billing	Y	N	Y	Y	Y	
Infrastructure	N	N	Y	Y	Y	
Net Mgt	N	N	Y	Y	Y	
DAK	Y	N	Y	Y	Y	
APP	N	N	Y	Y	Y	

Chapter 3
Functional Requirements

3.1 Functional Requirements

The following paragraphs describe the basic functional requirements of the DirecPC Turbo-Throttling feature.

3.1.1 [R:0019] Running Average Throughput

The HGW will maintain a running average throughput for all users. The running average will be calculated by using leaky-bucket approach where the bucket size will depend on N, Running Average Duration (where N will be a configuration parameter with a default value of 60 minutes).

3.1.2 [R:0033] Assign initial window size based on Service Plan

Each user should be assigned an initial per-TCP-connection window size. This window size is equal to the WMax parameter for the corresponding Service Plan. The user's TCP window size should never exceed this value.

Starting with Turbo-Throttling II, each user will be assigned an initial Peak Throughput (PeakUnThrottled Throughput) which will be used, in turn, to calculate the initial TCP window size. (Window Size = Throughput * RTT, RTT = Round-Trip Time)

3.1.3 [D:0022] Exclude first few minutes of usage every day from running average calculation

In order to provide the user with a better initial experience, the HGW will not include the first X minutes (where X is a configuration parameter, with a default value of 0) of data transfer each day in the calculation of running average throughput for each user. During this time, the window size should be equal to the WMax parameter for the corresponding Service Plan (irrespective of the user's current window size). WMax >= 536.

3.1.4 [R:0034] Clamp window size based on running average throughput

If the running average throughput exceeds a (service-plan configurable) threshold T1, the user's TCP window size should be clamped to W1. Similarly, if the bucket size exceeds a higher threshold T2), the user's TCP window size should be clamped to W2. W1 and W2 will each be greater than 536 bytes and WMax >= W1 >= W2, T1 <=T2.

Starting with Turbo-Throttling II, the window sizes will be calculated based on the Peak Throughputs (which are configurable on a service-plan basis).

3.1.5 [R:0036] Per-user Throughput Throttling

When a user is throttled, the available bandwidth (or window size) will be divided among the "bulk-transfer" type connections. A bulk-transfer connection is a connection which, in the recent past, has had unacknowledged bytes exceeding a certain threshold (Other connections are termed as "interactive"). Hence all connections start as "interactive" and may become "bulk-transfer" later. These definitions correspond to the ones used for flow control.

3.1.6 [R:0035] Provide two levels of UDP discard corresponding to T1 and T2

Non-DNS UDP traffic should be discarded if the user is being throttled. Just like window size clamping, there should be 2 levels of UDP discard, U1 and U2 (corresponding to W1 and W2 respectively). For example, U1 = 50 implies that at the first level of throttling, every 50th UDP packet will be discarded. Note that 1 <= U2 <= U1 <= 1000.

3.1.7 [R:0037] TCP Connection Limiting

The number of TCP connections that can be opened simultaneously by a user or a site will be limited to the MaxConnections configured for the corresponding service plan. The statistics regarding Number of connections open at any instant will be available via Enhanced Turbo-Internet statistics on a real-time basis.

3.1.8 [R:0038] Bucket Leak

Turbo-Throttling I used the Bucket Leak Rate to be the same as the Throughput Hard Threshold (T2). Also, the bucket leak happened only if a user was active in a particular minute. Starting with Version 2 of Turbo-Throttling, new parameters will be provided to specify the Bucket Leak Rate when a user is connected and also when a user is not connected. The Disconnected Bucket Leak Rate is being added in order to discourage ISP Bundled users from keeping their phone line up (at HNS' expense) just to reduce their running average throughput.

3.1.9 [D:0023] Use "connected" minutes for active minutes and running average calculation

The HGW must use the actual "connected" minutes for calculating the "active" minutes and running average throughput. For this purpose, the DAK software must be modified to notify the HGW about connection establishment, connection tear-down and connection-up events (connection-up event must be notified at periodic intervals).

The HGW software must be modified to accept these messages and to time-out if connection tear-down message is not received for D minutes (where D is a configuration parameter, with a default value of 3 minutes). This must be independent of TCP connection timeouts (idle-timeout etc).

3.1.10 Persistent data at HGW

The following data at the HGW needs to be maintained across user sessions and across HGW restarts:

- [R:0025] The Last state of user (throttled/non-throttled), Number of minutes the user has been connected in the day
- [D:0026] The Current Bucket Depth for a user, Minutes the user has been under hysteresis and number of UDP packets transmitted without any discards

3.1.11 [R:0031] Disable data forwarding to a user when not logged on

By default, the HGW must not forward data to a user who is not currently logged on. Data forwarding should be allowed on a service-plan basis.

3.1.12 [R:0012] Update of Service Plan information for each user

A utility will be provided to update the Service Plan information for each user (in the ACS/Oracle database) with the data received from the Billing subsystem. The data will be in the form of ascii-file where each line of the file will have a 10-character site-id, a serial number and a 2-character numeric Service Plan-id, with comma as the separating character.

3.1.13 [R:0039] Unlimited number of service plans

The limit of 30 service plans (in version 1 of Turbo-Throttling) will now be removed.

3.1.14 [R:0013] HGW reconfiguration

The Hybrid Gateway reconfiguration must be triggered off whenever there is a change in the Turbo-Throttling parameters or a change in an individual user's service plan.

3.1.15 [R:0042] Enhanced TIStats

The following statistics will be added to the displayed statistics and also added to the hourly records:

- Number of TCP connections rejected
- Number of Hard Throttled minutes
- Maximum Bulk Transfer Connections in the last hour
- Bytes Received by a user in the last hour (already being displayed; added to hourly records)
- Service Plan of user (already being displayed; added to hourly records)
- Hybrid Gateway Id for the user (will just be added to hourly records)

3.2 Non-Throttling requirements

The following HGW enhancements will also be performed as part of Turbo-Throttling II:

3.2.1 [R:0040] Local Key Table

The HGW maintains a table to store the encryption keys for each remote. The keys are received from the CAC via multicast messages. These messages contain keys for all remotes. In the past, each HGW used to store all these keys. This behavior will be changed in the new release and only keys for remotes assigned to the particular HGW will be stored in the HGW.

3.2.2 [R:0041] Change in Flow Control (FC) mechanism

The current Flow Control mechanism provides for a FCTWS (Flow-Controlled Target Window Size). Each user's window size at any instant is the minimum of this Target Window Size and User's Window Size based on Throttled state. When a flow control message is received with latency greater than a threshold, the FCTWS is reduced by a certain percentage. This behavior was appropriate earlier; but with Turbo-Throttling, this leads to a condition wherein a hard-throttled user's window size may not be affected at all (since it was already less than the new FCTWS) while a non-throttled user's window size may start shrinking, ultimately becoming comparable to that of a hard-throttled user.

Hence, starting with Turbo-Throttling II, the HGW will maintain a Flow Control Meter (FCMeter) with values between 1 and 100. This FCMeter value will vary with the latency values reported by the SGW. The user's window size at any stage will be obtained by multiplying this value with the window size value based on his service plan and the state of throttling.

3.3 Obsolete Requirements

The following requirements were suggested in an earlier version of the Requirements document, but were subsequently made obsolete due to change in business plans.

3.3.1 [X:0020] Terrestrial redirection of user traffic

When the running average throughput of a user exceeds T bits per second (where T is a configuration parameter, with a default value of infinity == 10Mbps, typical value would be 56*1024 == 56kbps), the user traffic will be re-directed terrestrially.

3.3.2 [X:0021] Return to satellite path

Once a user has been terrestrially re-directed, the user will be switched back if both the following conditions are satisfied:

- The running average throughput falls below T bits per second
- The user's traffic has been terrestrial for at least M seconds (where M is a configuration parameter, with a default of 60*4 == 4 minutes)

3.3.3 [X:0024] Updated Turbo-Internet Statistics

The Turbo-Internet Statistics must be enhanced to include the terrestrially-redirected bytes and the number of minutes of terrestrial redirection for each user in an hour. The running average throughput for each user must also be included in the Turbo-Internet Statistics.

3.3.4 [X:0027] Terrestrially redirect some portion of traffic at all times

The HGW must try to make use of the terrestrial bandwidth available by redirecting R kbps (where R is a configurable parameter, with a default value of 8kbps) of user traffic all the time.

3.3.5 [X:0028] Minimum session time

The NOC software should ensure that each user session lasts for at least S minutes (where S is a configurable parameter, with a default value of 5 minutes). This is required to prevent users from using the satellite only mode (in DAK) to download big chunks of data and then switch to Terrestrila only mode (in DAK). It should also be ensured that this implementation does not produce incorrect "connect minutes" in billing records.

3.3.6 [X:0029] Hourly usage notification to user

The HGW software will be enhanced to send a periodic usage-notification message to all configured DirecPC remotes (this activity should consume a very small satellite bandwidth). The DAK software will be enhanced to listen for these messages and update an hour-meter display which can be started by the user from within DirecPC Navigator Statistics.

The hour-meter must display actual usage v/s allotted quota per month and must pop up a dialog box when only 5 minutes of usage are left (or on session start with less than 5 minutes left).

3.3.7 [X:0030] Per-Service Plan, Per-HGW Turbo-Throttling parameters

The following configuration parameters will be configurable on a service-plan basis in the Auto-Commissioning Server. Based on the user's service plan and the corresponding service plan parameters, the HGW must use various Turbo-throttling mechanisms as described in the previous requirements.

- N, Number of minutes over which the running Average Throughput is calculated
- T, Threshold average Throughput for terrestrial redirection of user traffic
- M, Minimum number of seconds for which the user will be terrestrially redirected irrespective of whether the user's throughput falls below T before that period.
- X, eXcluded minutes: First few of minutes (on a daily basis) excluded from Running average Throughput calculation for each user
- R, Redirect-always throughput: Number of kbps of data which will be sent terrestrially all the time
- E, Enable Disconnect-Forward: If set, this will enable Data forwarding to a user who is not logged-on
- B, Down-Rev SW Block: If enabled, downrev software will not operate through the HGW. This would be employed for all users signing up for new service plans so that active minutes can be ensured to be the same as connected minutes.

3.3.8 New configuration parameters for Hybrid Gateway

The following new configuration parameters will be added (as new fields in the *hybridgws* table). All these parameters can be changed by the NOC operator and will immediately update Hybrid Gateway internal data structures after a Hybrid Gateway reconfiguration.

- [X:0001] PercentTerrRedirect: The percentage of users (for example, 10% of users in a list organized in descending order by throughput) in a particular priority level who will be moved to Terrestrial Redirection (simultaneously) on detection of congestion.
- [X:0002] CongestTimer: Whenever this timer goes off, the last received latency (from SGW) for each priority level is examined. If the value is greater than *LatencyThresh*, the *PercentTerrRedirect* highest-throughput users in that priority level will be switched to Terrestrial Redirection for duration equal to their *TerrRedirectMin* (TerrRedirectMin depends on Service Plan of user)
- User-specific configuration parameters: Each user's configuration record will be enhanced to include the following parameters (each of which is imported from the corresponding Turbo Internet service plan):
  - [X:0003] UserType: This determines the initial priority for a user in a particular service plan (that is, before any Throttling mechanisms are applied). This can have the following values:
    - 0 (default): "unlimited-access" user. The interactive traffic of such a user goes as Highest Priority while the bulk traffic will go as Medium, Low or Lowest Priority depending on the running average Throughput.
    - 1: "pay-per-byte" user. The interactive traffic of such a user goes as Highest Priority while the bulk traffic will go as High Priority irrespective of the running average Throughput.
  - [X:0004] TerrRedirectMin: Terrestrial Redirect Minutes (Default=5 minutes, value of 0 indicates no terrestrial redirection for this service plan).
  - [X:0005] ThruThreshMedPrio: Throughput Threshold for Medium Priority (default: 20kbps)
  - [X:0006] ThruThreshLowPrio: Throughput Threshold for Low Priority (default: 50kbps; If Throughput > ThruThreshLowPrio, user gets lowest priority)
  - [X:0007] RunningAvDuration: Running Average Duration used to calculate Throughput (default: 60 min, minimum: 10 min, maximum: 24*60 min)

3.3.9 New statistics at Hybrid Gateway and in Oracle Database

The Hybrid Gateways statistics gathering (and the Oracle database) will be enhanced to include the following new statistics:

- [X:0008] Mbytes downloaded/active minutes and terrestrial redirect bytes/minutes by user and priority level. These statistics should include total statistics and the per-application statistics and should be dumped on an hourly basis.
- [X:0009] Performance statistics which include: CPU usage, SGW latency values received (for each priority level), satellite throughput and terrestrial redirect throughput by priority level.

3.3.10 [X:0010] New priority levels at HGW and SGW

The following new priority levels (and associated Gateway Ids) will be introduced for TurboInternet traffic flowing from the Hybrid Gateway to the Satellite Gateway (Note: Priority 0 and 1 are reserved for Multimedia and Package Delivery traffic):

- Priority 2/Id 1: Interactive traffic (all service plans). This includes IP/UDP and light TCP traffic for all users

- Priority 3/Id 7: (High Priority) Bulk transfer traffic of per-Mbyte users (This includes the Basic and Bulk service plans)
- Priority 4/Id 8: (Medium Priority) Bulk transfer traffic of "unlimited access" (or non-pay-by-Mbyte) users whose average throughput is less than *ThruThreshMedPrio*
- Priority 5/Id 9: (Low Priority) Bulk transfer traffic of "unlimited access" (or non-pay-by-Mbyte) users whose average throughput is greater than *ThruThreshMedPrio* but less than *ThruThreshLowPrio*
- Priority 6/Id 10: (Lowest Priority) Bulk transfer traffic of "unlimited access" (or non-pay-by-Mbyte) users whose average throughput is greater than *ThruThreshLowPrio*

3.3.11 [X:0011] Terrestrial return of Turbo-Internet traffic

The hybrid gateway should allow for terrestrial redirection of all traffic for a user for a configured duration. Initially, only bulk TCP traffic will be terrestrially redirected.

3.3.12 Hour-meter display

The DAK software will provide a display of the hourly usage over the current month and the allotted hours for the month. This is covered under [X:0029]

3.4 [R:0032] User Interface

All user interface changes must be approved by the lead engineer responsible for user-interface design and development. All internationalization issues involved in such changes must also be considered.

3.4.1 [R:0014] Configuration of Turbo-Throttling parameters via Oracle Forms

The Oracle Forms must be enhanced to allow configuration of Turbo-Throttling parameters (mentioned in [R:0030]) by the NOC operator. This enhancement should take into account any issues related to the internationalization features (e.g., "internationalized" character set) inherent in Oracle 7.3 and later releases.

3.5 External Interface Requirements

This section intentionally left blank.

3.5.1 User Interfaces/Characteristics

This section intentionally left blank.

3.5.2 Hardware Interfaces

This section intentionally left blank.

3.5.3 Software Interfaces

This section intentionally left blank.

3.5.4 Communications Interfaces

This section intentionally left blank.

3.5.5 Network Management Interfaces

This section intentionally left blank.

3.6 Expected Enhancements

This section intentionally left blank.

Chapter 4
System Attributes

This section documents the non-functional requirements of DirecPC Turbo Throttling feature.

4.1 Performance

4.1.1 [R:0015] No impact on existing Billing/Performance statistics

Turbo Throttling must not affect the Billing/Performance statistics being gathered at present, except that the active minutes will now equal "connected" minutes.

4.2 Capacity and Resources

This section intentionally left blank.

4.3 Scalability

This section intentionally left blank.

4.4 Design Constraints

This section intentionally left blank.

4.4.1 [R:0016] Standards Compliance

All phases of implementing the requirements set forth in this document shall be ISO 9001 compliant as set forth by HNS ISO 9001 procedures and practices.

4.4.2 Hardware Limitations

This section intentionally left blank.

4.4.3 Physical Environment Considerations

This section intentionally left blank.

4.4.4 Timing Constraints

This section intentionally left blank.

4.4.5 [R:0017] Software Compatibility/Environment Considerations

The feature must operate on Windows NT HGW and must be compatible with other OS/2 or WinNT MUX components.

4.4.5.1 [R:0043] Backwards Compatibility

1. If the database is upgraded without a particular HGW being upgraded, that HGW will just ignore the new parameters. Or if the new version of HGW is replaced by the older version, it will continue to function as before.
2. If the HGW is upgraded without a database upgrade, the HGW will assume a value of 100 for MaxTCPConnections for all service plans. Also it will assume Throttling I, with DisconnLeakRate = 0.

4.4.6 Unit Cost

This section intentionally left blank.

4.5 Time to Market

This section intentionally left blank.

4.6 Testability

This section intentionally left blank.

4.7 Attributes

This section intentionally left blank.

4.7.1 Availability

This section intentionally left blank.

4.7.1.1 Startup/Recover Time

This section intentionally left blank.

4.7.1.2 Fault Tolerance

This section intentionally left blank.

4.7.1.3 Mean Time Between Failure (MTBF)

This section intentionally left blank.

4.7.2 Security

This section intentionally left blank.

4.7.3 Privacy

This section intentionally left blank.

4.7.4 Debugging/Trace Capability

This section intentionally left blank.

4.7.5 [R.0018] Maintainability

The following new documents will be created for this feature:

- DirecPC Turbo Throttling Feature Requirements Specification (Pubs No. HNS-11232)
- DirecPC Turbo Throttling Feature Design Specification (Pubs No. HNS-11422)
- DirecPC Turbo Throttling Feature Integration Test Plan (Pubs No. HNS-12090)

The following documents will be updated for this feature:

- DirecPC NOC Manual (Pubs No. HNS-7013).
- DirecPC Hybrid Internet Technical Specification (Pubs No. 8050744)
- DirecPC Oracle Schema Document (Pubs No. HNS-6896)
- DirecPC Product Technical Specification (Pubs No. 8050134)

The following are the other deliverables:

- Executables for WinNT-based HGW
- New DAK software
- SCO UNIX shell scripts and executables for uploading service-plan information from the Billing system and updating the Oracle Database
- Enhanced Oracle Forms to allow changes in Turbo-Throttling parameters (on a service-plan basis)
- Enhanced Oracle triggers to reconfigure Hybrid Gateways with change of service plan of individual users and/or change in Turbo-Throttling parameters
- ACS Upgrade Procedure

4.7.6 Adaptability

This section intentionally left blank.

4.7.7 Portability

This section intentionally left blank.

4.8 Installation Requirements

This section intentionally left blank.

4.9 Customization Requirements

This section intentionally left blank.

4.10 Other Requirements

This section intentionally left blank.

EXHIBIT 3

Roderick Ragland
[redacted] 02:14 PM

To: Dave Zatloukal/HNS@HNS, Doug Dillon/HNS@HNS, Ramesh Belani/HNS@HNS, Bill Donnellan/HNS@HNS, Tom Naugler/HNS@HNS, Matt Kenyon/HNS@HNS
cc: John Kenyon/HNS@HNS, Vivek Gupta/HNS@HNS, Richard Lodwig/HNS@HNS

Subject: Traffic Management Meeting Minutes

Attached is a copy of the traffic mangement meeting minutes for your review. The next meeting will be in Dave's office on Wednesday [redacted] at 9:00am.

Rod Ragland

(See attached file: TMMM [redacted].doc)

[redacted]

Traffic Management Meeting Minutes

ATTENDEES: Dave Zatloukal, Doug Dillon, Rod Ragland

DATE: Wednesday, [redacted]

SUBJECT: Weekly Status Meeting

AGENDA

[redacted]

4) Doug presented his detailed spread sheet analysis of the Turbo-Throttling II parameters per service.

ACTIONS ITEMS

[redacted]

3) Rod will analyze MoonSurfer statistics from Turbo-Throttle II gateways. From his analysis it will show: percentage of minutes throttled against total; percentage of users throttled; histogram of records sorted by throughput over the hour; histogram of users sorted by total Mbytes; and, histogram of users sorted by connect time (to be completed within 1 week).

[redacted]

EXHIBIT 4

Harvey Lindenbaum
[redacted] 04:36 PM

To: John Kenyon/HNS@HNS, Barbara Stavely/HNS@HNS, fkelly
cc: Ramesh Belani/HNS@HNS, bstanton, Mark Petronic/HNS@HNS, William Chao/HNS@HNS, Doug Dillon/HNS@HNS, ifaenson, Jerry Longo/HNS@HNS, Vivek Gupta/HNS@HNS, Satyajit Roy/HNS@HNS, murr, Vaishali Sesha/HNS@HNS, Anuj Varma/HNS@HNS, Roderick Ragland/HNS@HNS, Tsanchi Li/HNS@HNS, Gabriel Olariu/HNS@HNS, Anil Vohra/HNS@HNS, msyed, Trung Tran/HNS@HNS, Matthew Baer/HNS@HNS, Rajeev Kubba/HNS@HNS

Subject: DirecPC Weekly Report

ENGINEERING WEEKLY REPORT BY PRODUCT LINE

WEEK ENDING: [redacted] PROJECT LEADER: Harvey Lindenbaum

PRODUCT LINE: DirecPC JOB NUMBER: 12542, 12543

PRODUCT: DirecPC

RED FLAG ITEMS: None

MAJOR ACCOMPLISHMENTS/MILESTONES:

Turbo Throttling 2
FIT testing of Turbo Throttling 2 has been completed. It has been turned over to
Ramesh Belani for Release Testing.

[redacted]